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10/621,870	07/17/2003	Yong-Soo Kim	51876P358	1746

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EXAMINER	
KENNEDY, JENNIFER M	

ART UNIT	PAPER NUMBER
2812	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/621,870	KIM, YONG-SOO	
	Examiner	Art Unit	
	Jennifer M. Kennedy	2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 July 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-16* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-16* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *17 July 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *7/17/2003*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Specification

The disclosure is objected to because of the following informalities: On page 4, line 18 the examiner suggests replacing Al2O3 with --Al_2O_3--.

Appropriate correction is required.

Claim Objections

Claim 1 is objected to because of the following informalities: In line 4 of the claim the examiner believes that –by—should be inserted after "semiconductor substrate" for grammatical correctness. Appropriate correction is required.

Claim 2 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claim 2 requires that the silicon oxide layer is formed by performing an atomic layer deposition. Claim 1 also requires that the silicon oxide layer is formed by performing an ALD process, therefore Claim 2 does not further limit Claim 1.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 11 and 12 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. With respect to claim 11, it is unclear to the examiner which ALD process, the ALD process to form SiO_2 or the ALD process to form Al_2O_3, requires plasma as the energy source. Further, with respect to claim 12, it is unclear to the examiner which ALD process, the ALD process to form SiO_2 or the ALD process to form Al_2O_3, requires the process to be carried out at room temperature or at a temperature of about 500°C. The examiner suggests amending claims 11 and 12 to state either -- the ALD process to form Al_2O_3 -- or -- the ALD process to form SiO_2 -- where appropriate.

Similarly, while it is clear in claim 10, that "the ALD" process that is referred to is the ALD process to form Al_2O_3 because of the precursors being utilized, the examiner suggests amending claim 10, to state -- the ALD process to form Al_2O_3 -- , for consistency.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3, 9-10, and 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (U.S. Patent Appl. 2003/0049942) in view of Lee (U.S. Patent No. 6,355,519).

In re claim 1, Haukka et al. disclose the method including:

forming a lower electrode constituted with a silicon layer on a semiconductor substrate by a predetermined process on which a predetermined process has been completed (see paragraph [0068] and Figure 1, wherein the examiner considered the predetermined process that has been completed the cleaning of the substrate);

forming a uniform silicon oxide layer (30, see paragraph [0029] and [0040]) on the lower electrode by performing an atomic layer deposition (ALD) process;

forming an aluminum oxide (Al_2O_3) film on the silicon oxide layer (see [0041], [0043], [0048]-[0056] and Table 1).

Haukka et al. does not disclose the method wherein the Al_2O_3 film is crystallized by carrying out a heat treatment process. Lee discloses the method of crystallizing a Al_2O_3 film by a heat treatment process (see column 4, line 60 through column 5, line 27). It would have been obvious to one of ordinary skill in the art at the time the invention was made to crystallize the Al_2O_3 film by a heat treatment process because as Lee teaches it improves the dielectric characteristic.

In re claim 2, Haukka et al. disclose the method wherein the silicon oxide layer is formed by performing an atomic layer deposition process (30, see paragraph [0029] and [0040]).

In re claim 3, Haukka et al. disclose the method wherein the silicon oxide layer is formed by using an in-situ method or an ex-situ method (see paragraph [0067]).

In re claim 9, Haukka et al. disclose the method wherein Al_2O_3 film is formed by performing an ALD process (see [0041], [0043], [0048]-[0056] and Table 1) .

In re claim 10, Haukka et al. disclose the method wherein $Al(CH_3)_3$, which is trimethylaluminum (TMA), is used as an aluminum source, and one of H_2O, O_3, and H_2O_2 is used as a reaction source during the ALD process (see [0041], [0043], [0048]-[0056] and Table 1).

In re claim 14, Lee discloses the method wherein the heat treatment process is carried out at a temperature greater than 600 °C and in an N_2 or O_2 ambient.

In re claim 15, Lee discloses the method wherein the heat treatment process is carried out by using a furnace annealing process or a rapid thermal process (RTP)

In re claim 16, Haukka et al. does not disclose the method wherein an upper electrode constituted with a metal layer, a silicon layer or a metal layer/silicon layer is formed on an area of the crystallized Al_2O_3 film.

Lee discloses the method wherein an upper electrode (23) constituted with a metal layer; a silicon layer or a metal layer/silicon layer is formed on an area of the crystallized Al_2O_3 film (see column 5, lines 34-36, and column 4, lines 15-20). It would

have been obvious to one of ordinary skill in the art at the time the invention was made to form the upper electrode of a silicon layer (polysilicon) since it is a conductive layer that allows for complete formation of the capacitor structure. Further, utilizing silicon, the same material as that of the lower electrode, reduces the complexity of the formation of the capacitor since common process conditions and apparatus may be used for both upper and lower electrodes.

Claims 4-5 and 7-8, are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (U.S. Patent Appl. 2003/0049942) and Lee (U.S. Patent No. 6,355,519) in view of Klaus et al. (U.S. Patent No. 6,090,442).

In re claims 4 and 5, Haukka et al. and Lee disclose the method as claimed and rejected above, but do not disclose the particulars of the method of forming the silicon oxide, including wherein the silicon source selected from the group of $SiCl_4$, DCS, and HCD and a reaction source selected from a group consisting of H_2O, O_3, and H_2O_2 are used to form the silicon oxide, and wherein pyridine acting as a catalyst is used when the silicon source and the reaction source are supplied during the ALD process.

Klaus et al. disclose the method wherein the silicon source selected from the group of $SiCl_4$, DCS, and HCD and a reaction source selected from a group consisting of H_2O, O_3, and H_2O_2 are used to form the silicon oxide, and wherein pyridine acting as a catalyst is used when the silicon source and the reaction source are supplied during the ALD process (see column 5, lines 5-40).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the silicon oxide of Haukka et al. by the method of Klaus et al. because as Klaus et al. discloses the method allows for a low temperature deposition process (see column 10, lines 20-25) which will reduce the thermal budget of forming the capacitor.

In re claim 7, Klaus et al. discloses the method wherein the silicon oxide layer is formed at a low temperature less than about 200 °C (see column 5, lines 5-40, and column 10, lines 20-25).

In re claim 8, Haukka et al. discloses the method wherein a thickness of the silicon oxide is less than about 10 angstroms (see paragraph [0029]).

Claims 4 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (U.S. Patent Appl. 2003/0049942) and Lee (U.S. Patent No. 6,355,519) in view of Tera et al. (U.S. Patent Appl. 2001/0031379).

In re claim 4 and 6, Haukka et al. and Lee disclose the method as claimed and rejected above, but do not disclose the particulars of the method of forming the silicon oxide, including wherein the silicon source selected from the group of $SiCl_4$, DCS, and HCD and a reaction source selected from a group consisting of H_2O, O_3, and H_2O_2 are used to form the silicon oxide and wherein each of a supply time and a purge time for the silicon source and the reaction source is less than 10 seconds respectively.

Tera et al. disclose the method wherein silicon source selected from the group of $SiCl_4$, DCS, and HCD and a reaction source selected from a group consisting of H_2O,

O_3, and H_2O_2 are used to form the silicon oxide and wherein each of a supply time and a purge time for the silicon source and the reaction source is less than 10 seconds respectively (see Figure 12, and [0104]).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the silicon oxide layer by the method of Tera et al. because as Tera et al. teaches it allows for a uniform thin dielectric layer of silicon oxide with excellent step coverage (see paragraph [0008] and [0044]) which is desirable in capacitor fabrication.

Claims 11 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (U.S. Patent Appl. 2003/0049942) and Lee (U.S. Patent No. 6,355,519) in view of Sarigiannis et al. (U.S. Patent Appl. 2004/0033688).

In re claim 11, Haukka et al. and Lee disclose the method as claimed and rejected above, but do not disclose wherein plasma is used as the energy source during the ALD process.

Sarigiannis et al. discloses the method of utilizing plasma in formation of an Al_2O_3 film by ALD (see paragraph [0017] and [0027]).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize plasma in the formation of the Al_2O_3 film in the method of Haukka et al. because adding plasma, as known in the art, reduces the temperature at which the reactions will occur, thus allowing for reduction of the thermal budget of the capacitor.

In re claim 12, Haukka et al., Lee and Sarigiannis et al. do not disclose the method wherein the ALD process is carried out at a room temperature or at a temperature of about 500 °C. The examiner notes that 400°C is considered to be "about 500°C", especially in light of the specification (page 10, lines 9-13), in which the Applicant defines about 500°C to be from a range of about 200°C to about 500°C. Furthermore, the examiner notes that Applicant does not teach that a temperature of "about 500°C" solves any stated problem or is for any particular purpose. Therefore, this temperature lacks criticality in the claimed invention. Haukka et al. teaches the same method at a temperature of about 400°C (see paragraph [0048]). Thus, it would have been obvious to one of ordinary skill in the art to perform steps at "about 500°C" since the invention would perform equally well whether at 400°C or "about 500°C" to provide a temperature capable of forming a high-k dielectric by an ALD process without increasing the thickness of the interfacial dielectric layer (see paragraph [0048]), and because it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller,* 105 USPQ 233, MPEP 2144.05 II A.

Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (U.S. Patent Appl. 2003/0049942) and Lee (U.S. Patent No. 6,355,519) in view of Raaijmakers et al. (U.S. Patent Appl. 2001/0024387).

Haukka et al. and Lee disclose the method as claimed and rejected above, but do not disclose the method wherein a thickness of the Al_2O_3 film is less than about 100

angstroms. Raaijmakers et al. discloses the method of forming an Al_2O_3 film to a thickness of less than about 100 angstroms (see paragraph [0083]).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the film of Haukka et al. to a thickness of less than about 100 angstroms, because, as Raaijmakers et al. teaches 100 angstroms allows for a sufficiently thick metal oxide that avoids leakage during memory cell operation and allows for near perfect step coverage which is desirable in high surface area, high aspect ratio, capacitor fabrication (see paragraph [0083]).

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Nguyen (U.S. Patent No. 6,689,220) discloses that plasma enhanced ALD allows for a reduced temperature requirement (see column 2, lines 32-40).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jennifer M. Kennedy whose telephone number is (571) 272-1672. The examiner can normally be reached on Mon.-Fri. 8:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Niebling can be reached on (571) 272-1679. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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